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MINISTRY OF SUPPLY

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN

VENOM FB. MK.1 WE.272
(GHOST 103)

HANDLING CHECKS ON A PRODUCTION AIRCRAFT WITH MODS. 24.1, 24.2 AND 251 EMBODIED

5/52 (A1513) Wt.33812/798. 40M. 2. 2/53. H. E. & S. Gp.848

RESTRICTED

23rd Part of Report No. AAEE/868

27. AUG. 1953

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN

Venom FB. Mk.1 WE.272
(Ghost 103)

Handling checks on a production aircraft with Mods 241, 242 and 251 embodied

A. & A.E.E. Ref.: AAEE/5719,k/10.
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Period of Test : September 1952 - April 1953.

Progress of issue of Report

Report No.		Title
18th Part AAEE/868	WE.259	Intensive flying trials.
19th - do -	WE.256	Hood jettison tests in the Blower Tunnel.
20th - do -	WE.280	Note on a "Rogue" production aircraft.
21st - do -	WE.260	Tests of a prototype stick shaker installation.
22nd - do -	WE.260	Brief preliminary assessment of power operated ailerons.

Summary

Venom Mod. 242 introduces fixed wing tip slats with the object of improving the stalling characteristics of the Venom FB. Mk.1; Mod. 241 introduces balance weights in the nose of the wing tip tanks with the object of eliminating wing tip tank oscillations; and Mod. 251 replaces the round trailing edge strip of the aileron spring tabs by flat section strip with the object of eliminating aileron tab "buzz".

Handling tests on a production Venom FB. Mk.1 aircraft, WE.272, have shown that in so far as that particular aircraft is concerned these modifications have had the desired effect.

Tests proceeding simultaneously on another Venom FB. Mk.1 aircraft, modified to the same extent as WE.272 have, however, shown that severe aileron tab "buzz" and wing tip tank oscillations can still occur (see 20th Part of this Report); Mods. 241 and 251 are therefore of only limited value. Furthermore until it has been established that the aileron "buzz" is not influenced by the wing tip slats, Mod. 242 is also of doubtful value.

Removal of the spoiler strip from the rudder trailing edge (S.T.I./Venom/4) does not appear to have adversely affected the directional characteristics of the aircraft, but rudder buffet still occurs at high I.M.N. at low altitudes.

This report is issued with the authority of

Air Commodore,
Commanding A. & A.E.E.

/Introduction....

1. Introduction

Venom Mods. 241 (to introduce balance weight in the nose of the wing tip tanks), 251 (to fit flat trailing edge strip to the aileron spring tabs in lieu of round strip), and 242 (to introduce wing tip slats) were introduced with the object of improving the handling characteristics of the Venom FB. Mk.1. It was claimed that Mod. No. 241 eliminated aileron tab "buzz" with the tip tanks on, Mod. No. 251 reduced the amount of tab "buzz" with tip tanks off, and that Mod. No. 242 improved the stalling characteristics and thereby the take-off and landing characteristics.

Handling checks have been made on a production Venom FB. Mk.1 with these modifications embodied; the results are reported herein.

2. Condition of aircraft relevant to tests

2.1. General. Apart from the hitherto non-standard features detailed in para. 2.2., WE.272 was an otherwise standard production Venom FB Mk. 1.

2.2. Details of modifications etc.

2.2.1. Venom Mods. 241, 242 and 251. Venom Mod. 241 introduced a 10 lb. lead, annular, balance weight in the nose of each tip tank; this weight was fitted around the navigation light.

Photographs of the fixed wing tip slats introduced by Mod. 242 are included in this report. Each slat was of 18¾ inches span and 4¾ inches chord, was located so as to just clear the strake on the tip tank, and protruded approximately 3⅝ inches in front of the leading edge of the wing.

Venom Mod. 251 introduced ⅝ inch flat strip along the trailing edge of each aileron spring tab in lieu of the original ⅜ inch outside diameter round strip.

2.2.2. S.T.I./Venom/4. In accordance with S.T.I./Venom/4 the spoiler strip had been removed from the trailing edges of the rudders and rudder trim tabs with the object of eliminating rudder buffeting.

2.2.3. Aileron rigging. At the beginning of the tests the ailerons were rigged 4° up as on all production aircraft. At the request of the Firm (their letter ref. FHB/JBP dated 28th October, 1952 refers) the ailerons were rigged neutral and those tests already completed were repeated with the ailerons so rigged.

2.3. Flying limitations. The flying limitations applicable to WE.272 were given in an R.D.(A) Form 13 dated 17th September, 1952; relevant extracts are given in Appendix I.

2.4. Loading conditions. The aircraft was flown at the following take-off loading conditions.

Loading No.	Details of loading	Take-off weight (lb)	C.G. position in inches aft of datum and % S.M.C.			
			U/c down		U/c up	
			Inches aft	%S.M.C.	Inches aft	%S.M.C.
1	Full internal fuel; no wing tip tanks; full ammunition load.	11,580	11.5	26.4	11.6	26.5
2	Full internal fuel; full wing tip tanks; full ammunition load.	12,990	14.5	29.8	14.6	29.9

/The....

The above loadings represent typical service loadings for the fighter role, with and without wing tip tanks. The nominal take-off C.G.'s at these loadings are 26.1% S.M.C. and 29.5% S.M.C. undercarriage down (see Fig. 1 of the 17th Part of this Report). As WE.272 was presumably in the condition in which a production aircraft would be delivered to the Service, the aircraft was not ballasted to the nominal take-off C.G. but was flown as received as a typical production aircraft.

The Firm are conscious of this trend for the C.G. to move aft, and tests have now been made to clear the aircraft for take-off at 31.8% S.M.C., undercarriage down, to cater for the ferrying role i.e. full tip tanks and no ammunition in addition to rearward shift due to production variations. (See 25th Part of this Report).

3. Tests made

Tests were made at each loading to investigate the stalling characteristics, take-off and landing characteristics, characteristics of flight at high Mach numbers, and the lateral and directional characteristics.

4. Results of tests

4.1. Stalling characteristics

4.1.1. In straight flight. The stalling characteristics were investigated in straight flight at about 9,000 ft. at each loading in each of the following conditions.

(a) Flaps and undercarriage up, power off.
(b) Flaps and undercarriage down, power off.
(c) Flaps and undercarriage down, 7000 r.p.m.

The tests at Loading 1 (tip tanks off) were made initially with the ailerons rigged 4° up and repeated with the ailerons rigged neutral; the tests at Loading 2 (tip tanks on) were made only with the ailerons rigged neutral.

Details of the pre-Mod. 242 inconsistencies in stalling characteristics were given in the 14th Part of this Report. In comparison the stalling characteristics with Mod. 242 embodied were better in that the stall was preceded (except in one isolated instance) by controllable wing dropping. There was still, however, quite considerable variation in the speed interval between the onset of controllable wing dropping and the stall. In many instances lateral trim changes were apparent at speeds about 10 knots above the stall, but in others the margin was small - about 2 knots. The magnitude of the initial lateral trim change also varied from slight wing heaviness to a definite wing drop, which, in the isolated instance mentioned above, was of an intensity which suggested that for practical purposes, the aircraft was stalled.

As on previous Venom aircraft the stalling speeds appeared to vary from stall to stall, while A.S.I. flicker tended to mask the actual stalling speed on any particular occasion. The stalling speeds quoted below are therefore very approximate.

	Loading 1	Loading 2
Flaps and undercarriage up, power off	95 - 100 kts. I.A.S.	100 - 105 kts. I.A.S.
Flaps and undercarriage down, power off	80 - 90 kts. I.A.S.	85 - 90 kts. I.A.S.

The effect of thrust on stalling speed was small. Re-rigging the ailerons from 4° up to neutral did not appear to materially affect the stalling characteristics.

/4.1.2....

4.1.2. Turning flight. The stalling characteristics in turns were investigated between 9,000 - 10,000 ft. at 200 knots I.A.S. (airbrakes in) and 170 knots I.A.S. (airbrakes out) at Loading 1, and at 230 knots I.A.S. (Airbrakes in) and 170 knots I.A.S. (airbrakes out) at Loading 2. The tests at Loading 1 were again made with both aileron riggings and the tests at Loading 2 with neutral aileron rigging only.

In each condition the stalling characteristics followed the normal Venom pattern in that at the stall the aircraft rolled into the turn in turns to port, and out of the turn in turns to starboard. If the 'g' was applied slowly the wing could be picked up with aileron, but if the 'g' was applied rapidly, recourse to rudder was necessary. Recovery was immediate on releasing the back pressure on the stick.

4.1.3. Snap stall. At each loading the snap stalling characteristics were investigated at about 9,000 ft. by sharply pulling up the nose of the aircraft from a 30° dive in which the aircraft was trimmed at 200 knots I.A.S. The stalling characteristics at the two loadings were similar. At the stall, which occurred at 4.0 'g' (accelerometer reading) at Loading 1, and 3.35 'g' (accelerometer reading) at Loading 2, there was moderate general buffeting, slight aileron buffeting, and mild alternate wing dropping which could be controlled with aileron. The stick force required to hold the stick fully back was moderately heavy, and the attitude was approximately that of level flight when the stall occurred.

The A.S.I. reading immediately before the stall occurred was not noted but immediately after the stall occurred the A.S.I. read about 100 - 110 knots and then fluctuated erratically between about 150 and 190 knots.

4.2. Take-off and landing characteristics. The take-off and landing characteristics, with particular reference to wing dropping tendencies immediately after becoming airborne and just before touching down, were checked at each loading, but principally at the normal operational configuration of Loading 2. The characteristics at that loading were as follows:

4.2.1. Take-off. Numerous take-offs were made in varying conditions of windspeed, crosswind component, and turbulence.

With the elevator trimmer set at neutral, and the flaps down 30°, the engine was opened up against the brakes to the full take-off r.p.m. of 10,250. On release of the brakes the stick was held fully back while the aircraft accelerated fairly rapidly to about 63 knots I.A.S. At that speed the nose of the aircraft rose sharply and the stick had to be moved forward to a position approximately midway between fully back and central to prevent the tail coming into contact with the runway. While doing so the speed increased to about 85 - 90 kts. I.A.S. and at the latter speed the aircraft became airborne. After becoming airborne the acceleration was rapid and before retracting the flaps and undercarriage a push force of about 12 lb. was required to maintain the desired attitude.

There was no tendency for either wing to drop but there was very mild wallowing. The ailerons were effective and response was good immediately after becoming airborne.

During take-offs with the flaps up the speeds at which the nose-wheel left the ground and the aircraft became airborne were some 10 to 15 knots higher than during take-offs with 30° flap, and at these higher speeds there was no wallowing after becoming airborne.

4.2.2. Landing. From an initial approach at 110 knots I.A.S. using 7,000 r.p.m. speed was reduced to 105 knots I.A.S. over the airfield boundary and to 100 knots I.A.S. when the throttle was closed just before reaching the end of the runway. After a short float the aircraft touched down at about 93 knots I.A.S. with the nose-wheel well up. There was a mild tendency toward wallowing during the final stages of the approach but even in strong gusty crosswind conditions this characteristic was not disturbing.

/4.3....

4.3. Flight at high I.A.S. with particular reference to aileron "buzz" characteristics. Aileron "buzz" was not encountered in any condition of flight at either loading nor was it found possible to induce "buzz" by application of 'g', extension of airbrakes, or by giving the stick a sharp lateral displacement at high I.A.S.

4.4. Characteristics of flight at high Mach number. The aircraft was flown at each loading up to 0.885 Mach number (0.855 I.M.N.) in dives from 45,000 ft., 0.875 Mach number (0.845 I.M.N.) in dives from 35,000 ft., and up to 0.855 Mach number (0.83 I.M.N.) in dives from 25,000 ft.

Within these limits the characteristics were representative of Venom FB. Mk. 1 aircraft previously tested at this Establishment and the modifications did not appear to have introduced any unusual characteristics. Rudder buffet still occurred however at high I.M.N. at low altitudes.

4.5. Lateral and directional characteristics.

4.5.1. Rate of roll measurements. Rates of roll were measured approximately at various speeds at 10,000 ft. using 10,000 r.p.m. Each roll was started from approximately 45° bank and the steady roll was timed through 360° from wings level to wings level. The results are given below.

I.A.S. (kts.)	Mean rate of roll (°/sec.)					
	Loading 1 (Tip tanks OFF) Ailerons rigged 4° up		Loading 1 (Tip tanks OFF) Ailerons rigged NEUTRAL		Loading 2 (Tip tanks ON) Ailerons rigged NEUTRAL	
	To the left	To the right	To the left	To the right	To the left	To the right
200	-	-	-	-	56	58
250	75	80	78	78	62	64
300	84	88	84	80	69	69
350	88	86	84	84	64	65
380	80	77	78	80	62	62
400	71	72	74	77	58	60
430	62	65	65	65	50	52

At speeds up to 350 knots I.A.S. full aileron was applied without difficulty; thereafter the lateral stick force increased progressively with speed, and at 430 knots I.A.S. full aileron could not be applied, the stick position being just short of the stops.

4.5.2. Oscillatory stability. Under each of the following speed and power conditions all control forces were trimmed out and without changing speed or trim the aircraft was put into a steady straight sideslip of about 5°; the behaviour on releasing the controls was observed.

(i) Climbing at 330 knots I.A.S. at 10,000 ft. (Loading 1)
(ii) Level flight at 200 knots I.A.S. at 10,000 ft. (Loading 1)
(iii) Level flight at 428 knots I.A.S. at 10,000 ft. (Loading 1)
(iv) Climbing at 330 knots I.A.S. at 10,000 ft. (Loading 2)
(v) Climbing at 300 knots I.A.S. at 20,000 ft. (Loading 2)
(vi) Climbing at 270 knots I.A.S. at 30,000 ft. (Loading 2)
(vii) Climbing at 215 knots I.A.S. at 40,000 ft. (Loading 2)
(viii) Level flight at 200 knots I.A.S. at 10,000 ft. (Loading 2)
(ix) Level flight at 420 knots I.A.S. at 10,000 ft. (Loading 2)
(x) Level flight at 230 knots I.A.S. at 40,000 ft. (Loading 2)

The characteristics at Loading 1 (tanks off) were normal for the type.

With wing tip tanks on, however, the lateral rocking which occurred in straight flight at low speeds appeared to be worse than on previous Venom FB Mk. 1, aircraft and when the controls were released in a sideslip there was pronounced lateral rocking. On first releasing the controls the aircraft began Dutch rolling, but the initial directional oscillations quickly subsided

/and....

and thereafter there was only a small amplitude directional oscillation associated with the pronounced lateral rocking. In all cases the aircraft tended to spiral in addition. With controls free the lateral rocking was virtually undamped but no difficulty was experienced in restoring normal flight using rudder and aileron.

4.5.3. Straight sideslips. Straight sideslips were made in each direction in the following conditions of flight:

(i) Climbing at 330 knots I.A.S. at 10,000 ft. (Loadings 1 and 2)
(ii) Level flight at 200 knots I.A.S. at 10,000 ft. (Loadings 1 and 2)
(iii) Level flight at 425 knots I.A.S. at 10,000 ft. (Loadings 1 and 2)
(iv) In a dive at 450 knots I.A.S. between 10,000 ft. and 5,000 ft. (Loadings 1 and 2)
(v) Gliding, flaps and undercarriage down, at 120 knots I.A.S. at 10,000 ft. (Loadings 1 and 2)
(vi) Climbing at 225 knots I.A.S. at 40,000 ft. (Loading 2)
(vii) Level flight at 200 knots I.A.S. at 40,000 ft. (Loading 2)
(viii) Gliding, flaps and undercarriage up at 170 knots I.A.S. at 40,000 ft. (Loading 2).

In each of the above conditions the foot force increased progressively with rudder displacement and there was no tendency to overbalance even at 40,000 ft. The amount of sideslip which could be applied was limited by rudder travel at low I.A.S. and rudder force at high I.A.S.

5. Discussion of results

5.1. Stalling characteristics. The stalling characteristics considered in isolation are deemed tolerable rather than good. Of greater practical significance however is the apparent elimination of the wing dropping tendencies during take-off and landing. It is therefore considered that, subject to the proviso of para. 5.2, Mod. 242 should be introduced with retrospective effect.

5.2. Aileron tab "buzz" and wing-tip tank oscillations. Aileron tab "buzz" and wing tip tank oscillations were first encountered at this Establishment on the second prototype Venom FB. Mk. 1, VV.613, (see 7th and 8th parts of this Report). At that time the ailerons were rigged neutral. The Firm then suggested that both these tendencies were in some cases eliminated by rigging the ailerons 4° up, and an early production aircraft, WE.255, tested at this Establishment immediately afterwards, with the ailerons so rigged was indeed free from "buzz" (see 9th Part of this Report). So too were all other Venom FB Mk. 1 aircraft flown at this Establishment up to the time of receipt of WE.272.

It is known, however, vide Firm's Flight Test Report Ref. 112/27/52 of 8.7.52 that severe tab "buzz" occurred on WE.272 before Mods. 241 and 251 were introduced. Therefore, in this particular instance, Mods. 241 and 251, have fulfilled their purpose.

It will be remembered that aileron tab "buzz" was originally encountered as a high I.A.S. condition. During recent tests on another Venom FB Mk.1 aircraft modified to the same extent as WE.272, very severe tab "buzz" and tip-tanks oscillations have been encountered at high I.M.N. at high and medium altitudes (see 20th part of this Report). Similar behaviour has also been encountered on a production aircraft at the Firm (see Firm's Flight Test Reports on WE.281). It is therefore apparent that Mods. 241 and 251 are only successful on particular aircraft.

It is understood that the fixed wing tip slats (Mod. 242) were abandoned on the Venom NF. Mk. 2 when aileron vibration was encountered, and although the little evidence available would suggest that in the case of the Venom FB. Mk. 1 the slats are not responsible for the tab "buzz" and tank oscillations (see Firm's Reports on WE.281) this will have to be determined with certainty

/before....

before the wing tip slats are made a standard fitting.

If and when power operated ailerons are introduced on the Venom FB. Mk.1 (see 22nd Part of this Report) the problem of aileron tab "buzz" and tip tank oscillations will no longer exist.

5.3. Lateral and directional characteristics. Removal of the spoiler strip from the trailing edge of the rudders (S.T.I./Venom/4) does not appear to have introduced snaking difficulties but rudder buffet still occurrs at high I.M.N. at low altitudes.

The other point of interest arising from the present tests is the lateral rocking which occurs at moderate to low I.A.S. with wing tip tanks fitted. This characteristic was noted the first time a Venom aircraft was flown with wing tip tanks at this Establishment (see 8th Part of this Report) and has been apparent in varying degrees on all FB Mk.1 aircraft flown to date. In the case of WE.272 the rocking is probably as bad, if not worse, than on any previous Venom FB. Mk.1, and the lateral oscillations induced by application and release of rudder are particularly unpleasant. Even so the aircraft is easy to control laterally and directionally. As stated in the 8th Part of this Report, however, the aiming characteristics may be adversely affected at high altitudes where speeds are such that this rocking occurs.

6. Conclusions

Tests on Venom FB. Mk. 1 WE.272 with Mods. 241, 242, and 251 embodied have shown (a) that the stalling characteristics are improved and there are no wing dropping tendencies during take-off or landing, and (b) that neither aileron tab "buzz" nor wing-tip oscillations occur in any condition of flight. Considered in isolation it would, therefore, appear that these modifications have had the desired effect. Tests proceeding simultaneously on another Venom FB Mk.1 aircraft modified to the same extent as WE.272 have, however, shown that very severe aileron tab "buzz" and tip tank oscillations can still occur (see 20th Part of this Report); Mods. 241, and 251 cannot therefore be considered entirely successful. Furthermore until it has been established that these "buzzing" tendencies are independent of the wing tip slats, the value of Mod. 242 is also doubtful.

S.T.I./Venom/4 does not appear to have had any adverse effect on the directional characteristics, but rudder buffet still occurs at high I.M.N. at low altitudes.

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/Appendix I....

Appendix I

Flying limitations

1. Maximum permissible speeds and Mach numbers

Stores carried	Max I.A.S. (kts.)	Max I.M.N.
None	535	0.86 above 40,000 ft. 0.84 from 30,000 ft. to 40,000 ft. 0.83 from 20,000 ft. to 30,000 ft. 0.815 below 20,000 ft. (or 535 knots I.A.S. whichever is the slower)
2 x 80 gallon tip tanks	510	0.85 above 40,000 ft. 0.83 from 30,000 to 40,000 ft. 0.82 from 20,000 ft. to 30,000 ft. 0.80 below 20,000 ft. (or 510 kts. I.A.S. whichever is slower).

Maximum speed with flaps down 155 knots I.A.S.
Maximum speed with undercarriage down 175 knots I.A.S.
Maximum speed for opening airbrakes 535 knots I.A.S.

2. Loading limitations

Maximum permissible take-off weight without tip tanks 11,750 lb.
" " " " with empty tip tanks 11,930 lb.
" " " " with full tip tanks 13,150 lb.
Maximum permissible normal landing weight without tip tanks 11,600 lb.
" " " " " with tip tanks 11,930 lb.
Maximum permissible overload landing weight (normal overload) 12,070 lb.
" " " " " (emergency only) 13,150 lb.
Maximum permissible nose-wheel load for take-off 1,595 lb.
" " " " " landing 1,420 lb.

3. Maximum permissible normal accelerations

Without tip tanks 6.0 'g' (accelerometer reading)
With either full or empty tip tanks 5.0 'g' (accelerometer reading)

4. Other limitations

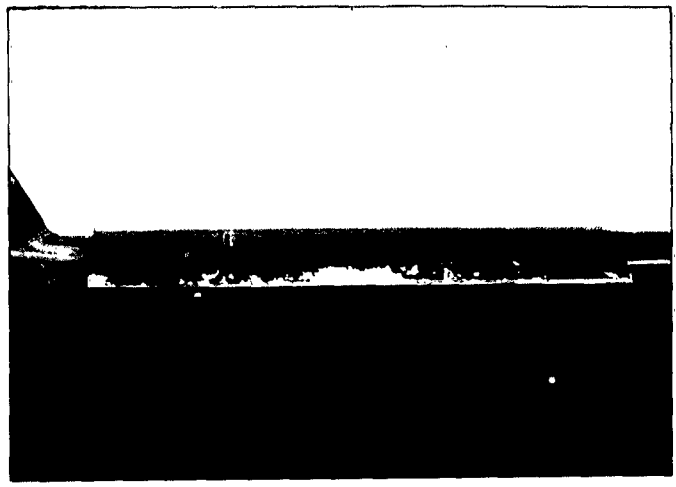
(i) Maximum safe crosswind component 30 knots for take-off at 13,150 lb. and landing at 11,750 lb.
(ii) Intentional spinning prohibited.
(iii) Maximum angle of sideslip (from design considerations) at 524 knots I.A.S.:- 3.6°.

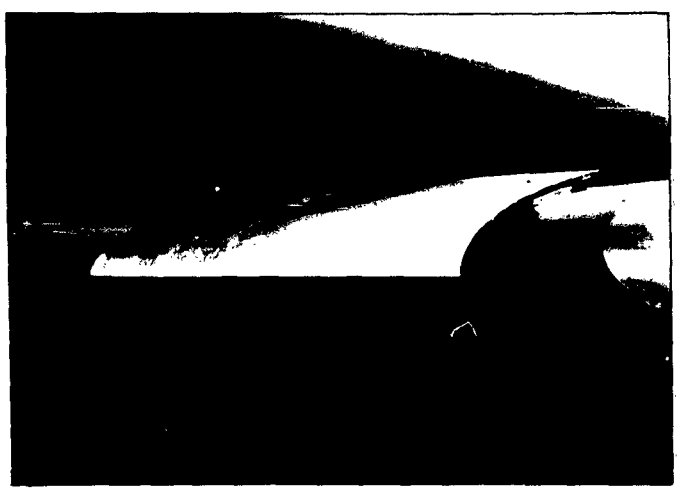
5. Engine limitations

The limitations applicable to the Ghost Mk. 103 engine at the time of test were as follows:

Condition	R.P.M.	Max. J.P.T. (°C)	Time limit
Take-off and operational necessity	10,250*	725	30 mins. total
Max. continuous	9,750	625	-
Approach idling	5,000		
Ground idling	3,000	450	

*On the climb the use of 10,250 r.p.m. is permitted up to 25,000 ft; above that height max. permissible r.p.m. is 10,100. In level flight the use of 10,250 r.p.m. is permitted up to 35,000 ft; above that height max. permissible r.p.m. is 10,100.





VENOM F.B.Mk 1.WE.272
Wing Tip Slat (Starboard)
(Wing tip tank fitted)

A. & A.E.E. NEG. No. 15936.

Information Centre
Knowledge Services
[dstl] Porton Down
Salisbury
Wilts
SP4 0JQ
22060-6218
Tel: 01980-613753
Fax 01980-613970

Defense Technical Information Center (DTIC)
8725 John J. Kingman Road, Suit 0944
Fort Belvoir, VA 22060-6218
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